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I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

I also certify that the attached copy of the request for grant of a Patent (Form 1/77) bears an amendment, effected by this office, following a request by the applicant and agreed to by the Comptroller-General.

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The Patent Office

1/77

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Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
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1.	Your reference	DC/MH/LB/5492UK
2.	Patent application number *(The Patent Office will fill in this part)*	29 SEP 1999 **9922875.1**
3.	Full name, address and postcode of the or of each applicant *(underline all surnames)*	Prodrive Limited, Acorn Way, Banbury, OXON, OX16 7XS
	Patents ADP number *(if you know it)*	7750789001
	If the applicant is a corporate body, give the country/state of its incorporation	
4.	Title of the invention	GEAR CHANGE MECHANISM
5.	Name of your agent *(if you have one)*	~~Lewis & Taylor~~ WITHERS & ROGERS
	"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	~~5 The Quadrant Coventry CV1 2EL~~ GOLDINGS HOUSE 2 HAYS LANE LONDON SE1 2HW
	Patents ADP number *(if you know it)*	711001 ✓

(JAM FS1/77 20.10.00)

6.	If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or each of these earlier applications and *(if you know it)* the or each application number	Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7.	If this application is divided or otherwise derived from an earlier UK application, give the number and filing date of the earlier application	Number of earlier application	Date of filing *(day / month / year)*

8.	Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'yes' if:* *a) any applicant named in part 3 is not an inventor, or* *b) there is an inventor who is not named as an applicant, or* *c) any named applicant is a corporate body.* *See note (d))*	YES

Enter the number of sheets for any of the following items you are filing with this form.
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Continuation sheets of this form	0
Description	10
Claim(s)	0
Abstract	0
Drawing(s)	5 x 5

10. If you are also filing any of the following, state how many against each item.

Priority documents	
Translation of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature [signature] Date 28 September 1999

12. Name and daytime telephone number of person to contact in the United Kingdom: David R Cowan 01203 222756

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Gear Change Mechanism

The present invention relates to a gear change mechanism and particularly, but not exclusively, to a gear change mechanism for effecting a gear change in a gearbox of a vehicle.

British Patent No. GB 2280004, in the name of the present applicant, discloses an hydraulic actuator for effecting a gear change in a vehicle gearbox whereby gear changes may be effected automatically upon the driver initiating a gear change operation. The present invention aims to provide an improved gear change mechanism.

Accordingly, there is provided a gear change mechanism for a gearbox, including a housing, a first actuator assembly disposed within the housing connectable to a gearbox selector, said gearbox selector being mounted on an axis and movable in an axial direction and about its axis to a plurality of positions for effecting a change of gear in said gearbox, the first actuator assembly including: a first cylinder, a first shaft located within the first cylinder, the first shaft being connected to said gearbox selector and movable to move said gearbox selector in said axial direction between a plurality of axial positions according to the gear to be selected in the gearbox, the first shaft being driven in said axial direction by a first piston assembly coaxial with the first shaft, the first piston assembly including a pair of annular pistons located about the first shaft, wherein said plurality of axial positions includes two end positions each corresponding to gears to be selected in the gearbox and two positions intermediate the end positions each corresponding to other gears to be selected in the gearbox.

The gear change mechanism may additionally include a second actuator assembly connectable to said gearbox selector, the second actuator assembly including a second cylinder, a second shaft located within the second cylinder, the second shaft being connected to said gearbox selector and movable in its axial direction to move said gearbox selector about it axis to a plurality of positions according to the gear to be selected in the gearbox,

the second shaft being driven in its axial direction by a second piston assembly coaxial with the second shaft, the second piston assembly including a pair of annular pistons located about the second shaft, wherein said plurality of positions includes two end positions each corresponding to gear engaging positions and position intermediate said end positions corresponding to a neutral gear position.

Preferably, the or each cylinder is divided into four chambers, each chamber being defined by one of said annular pistons and a respective portion of the cylinder and said chambers are arranged to be supplied with pressure fluid thereby to move said shaft relative to the cylinder.

Advantageously, each of a first two of said chambers may be constantly supplied with pressure fluid and each of a second two of said chambers may be selectively supplied with pressure fluid by a respective valve means connected thereto. Alternatively, each chamber in said cylinder may be selectively supplied with pressure fluid by a respective valve means.

Said pressure fluid may be pressurised hydraulic fluid or may be pneumatic fluid e.g. air. Alternatively, said first two of said chambers may be supplied with pressurised air and said second two of said chambers may be supplied with pressurised hydraulic fluid.

According to a second aspect of the present invention, there is provided a gear change mechanism for a gearbox including a housing, a first actuator assembly disposed within the housing connectable to a gearbox selector, said gearbox selector being mounted on an axis and movable in an axial direction and about its axis to a plurality of positions for effecting a change of gear in said gearbox, the first actuator assembly including a first cylinder, a first shaft located within the first cylinder, the first shaft being connected to said gearbox selector movable to move said gearbox selector in said axial direction between a plurality of axial positions according to the gear to be selected in the gearbox, the first shaft being driven in said axial direction by a first piston assembly co-axial with the first shaft, the first piston assembly including a pair of annular pistons located about the first shaft wherein said plurality of positions includes two end positions each corresponding to gears to be selected in the gearbox and at least one position intermediate the end positions said at least one

position corresponding to another gear or gears to be selected in the gearbox, wherein the first cylinder is divided into four chambers, each chamber being defined by one of said annular pistons and a respective portion of the cylinder and said chambers are arranged to be supplied with pressure fluid thereby to move said shaft relative to the cylinder each of a first two of said chambers being selectively supplied with pressure fluid by a respective valve means connected thereto and each of a second two of said chambers being arranged to draw in or force out pressure fluid according to movement of said pistons.

The present invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a perspective view of a preferred form of gear change mechanism according to the invention;

Figure 2 is a perspective view of a preferred form of gear selector mechanism according to the invention;

Figure 3 is a section through the gear change mechanism of Figure 1 on the line A-A showing a first actuator assembly in a left-most position;

Figure 4 is a section through the gear change mechanism of Figure 1 on the line A-A showing a first actuator assembly in a "middle left" position;

Figure 5 is a section through the gear change mechanism of Figure 1 on the line A-A showing a first actuator assembly in a "middle right" position;

Figure 6 is a section through the gear change mechanism of Figure 1 on the line A-A showing a first actuator assembly in a right-most position

Figure 7 is a section through the gear change mechanism of Figure 1 on line B-B showing a second actuator assembly in a central position;

Figure 8 is a section through the gear change mechanism of Figure 1 on the line B-B showing the second actuator assembly in the left-most position; and

Figure 9 is a section through the gear change mechanism of Figure 1 on the line B-B showing the first actuator assembly in the right-most position;.

Referring to Figure 1, a preferred form of gear change mechanism according to the invention is shown generally at 10. The mechanism is intended to be used primarily, but not exclusively, in an automatic or semi-automatic gearbox arrangement of a vehicle whereby gear changes are initiated by control signals applied to the mechanism which signals may be generated by a computer on the vehicle or manually by the driver of the vehicle.

In this embodiment, the mechanism 10 is powered hydraulically by pressurized fluid through a valve assembly (not shown). The control input signals referred to above are thus used to activate or deactivate selectively the valve assembly thereby to operate the gear change mechanism.

The mechanism 10 includes an outer housing 12 providing ports (not shown) for the introduction and discharge of hydraulic fluid to and from the mechanism. A gear selector mechanism, shown in detail in Figure 2, is disposed within a central portion 14 of the housing 12. The housing 12 also contains a first actuator assembly 18 and a second actuator assembly 16. The first actuator assembly 18 extends perpendicular to and below the second actuator assembly 16.

The gear selector mechanism 20 has an actuator arm 22, the purpose of which is described below, fixed to a substantially annular hub portion 26. A selector finger 24 is also fixed to the hub 26 diametrically opposed to the actuator arm 22. The hub 26 is mounted on a shaft 28 for sliding movement along the shaft and rotational movement about the axis of the shaft, the shaft being fixed within the housing 12.

The finger 24 is arranged to engage with a conventional gearbox (not shown) in known

manner such that movement of the arm either in the axial direction of the shaft 28 or rotationally about the shaft causes a change of gear in the gearbox. Specifically, there is shown in Figure 2 for illustrative purposes a typical gearbox layout with which the mechanism of the present invention can operate. The layout serves a seven-speed gearbox being of a so-called "double-H pattern", having gears 1 to 4 in a standard H pattern arrangement, and then a second H pattern arrangement for gears 5 to 7 and reverse.

Gears 1 and 2 are therefore opposite one another on the first "rail" of the gearbox, gears 3 and 4 are opposite one another on a second rail of the gearbox and gears 5 and 6 and gears 7 and reverse are opposite one another on third and fourth rails of the gearbox respectively, to provide a so-called four-rail gearbox. Other gear arrangements can also be accommodated by the mechanism 10 but the following description is made in relation to the illustrated arrangement.

As indicated in Figure 2, rotational movement of the arm 24 about the shaft 28 causes selection between gears which are opposite one another on a common rail, such as between gears 1 and 2 or between gears 5 and 6. Movement of the arm 24 in the axial direction of the shaft 28, on the other hand, causes selection of different rails.

In this embodiment, for example, gear selection between gears 1 and 2, gears 3 and 4, gears 5 and 6 and gears 7 and reverse requires only rotational movement of the arm 24, while gear selection between gears 2 and 3, gears 4 and 5 and gears 6 and 7 requires both rotational movement of the arm 24 to a central neutral position and then movement of the arm 24 in the axial direction of the shaft 28 to the next rail of the gearbox on which the target gear lies.

Separate drive means, in the form of actuator assemblies 16 and 18 are provided for each of the axial and rotational movements of the gear selector mechanism 20.

The drive means for the rotational movement of the gear selector mechanism 20 is achieved by actuator assembly 16, a section through which is shown in Figures 7 to 9. The actuator assembly 16 has a shaft 30 disposed axially within it for limited axial movement therealong.

The shaft 30 comprises two portions 32, 34 (hereinafter referred to as left- and right-portions 32, 34) joined by means of a central portion 36 of greatly reduced diameter. The presence of the central portion 36 provides a recess 38 in which an upper portion of the actuator arm 22 of the gear selector mechanism 20 is engaged.

The shaft also comprises end portions 40, 42 disposed on the free end of portions 32 and 34 respectively, the end portions being of slightly reduced diameter compared to portions 30 and 34. The reduced diameter of the end portions provides a shoulder 44, 45 on the left- and right-portions 32, 34 of the shaft respectively. The free end of each of the end portions 40, 42 has a snubber in the form of a plate 46, 48 of slightly increased diameter.

Each end of the cylinder is provided with a recess 50, 52 being sized to receive the respective snubber 46, 48 on the shaft 30. The shaft 30 is free to move axially within the cylinder such that when the shaft is at its left-most position, the snubber 46 is seated in the recess 50. Conversely, when the shaft is in its right-most position, the snubber 48 is seated in the recess 52.

Each end portion of the shaft 40, 42 has a respective annular piston 54, 56 slidably mounted thereon. Each piston is free to slide along the respective end portion of the shaft but its movement is restricted by the shoulder 44, 45 at one end and the snubber 46, 48 at the other end. Relative movement of the pistons within the cylinder is also restricted by the ends of the cylinder and by a respective abutment means in the form of a sealing collar 58, 60 located adjacent the middle of the cylinder.

The sealing collars 58, 60 and the pistons 54, 56 serve to divide the cylinder into four distinct chambers A - D, chamber A being defined between the left end (as depicted in the drawing) of the cylinder and the piston 54, chamber B being defined between the piston 54 and the left-hand sealing collar, chamber C being defined between the right-hand sealing collar and piston 56 and chamber D being defined between the piston 56 and the right-hand end of the cylinder.

Each chamber has a respective port (not shown) to allow pressurised fluid (hydraulic or pneumatic) to enter and/or to be discharged therefrom. In this embodiment, the feeding of fluid to and discharging from chambers A and D is each controlled by a valve (not shown). The left and right sealing collars 58, 60 defining respective ends of chambers B and C are arranged to allow trapped air and hydraulic fluid within chambers 2 and 3 to be vented to the gearbox cavity.

Movement of the shaft 30 will now be described. Movement of the shaft to a central position (Figure 7), causing movement of the gear selector assembly into a neutral position, is achieved by actuating the valves mentioned above in order to supply chambers A and D with pressurized hydraulic fluid. The pressurized fluid forces the pistons 54 and 56 to move towards each other on the shaft and engage the respective shoulders 44, 45. The shaft thus moves into a central position with the pistons abutting with both the shaft shoulders and the sealing collars.

This movement of the shaft causes the actuator arm 22 of the gear selector mechanism 20, engaged in the recess 38, to rotate to a central position corresponding to neutral in the gearbox.

Movement of the shaft to the left (Figure 8) is achieved by actuating the valves to cause chamber D only to be supplied with pressurized hydraulic fluid. The shaft 30 moves to the left owing to the pressurized fluid in chamber D until the snubber 46 is seated in the recess 50 in the end of the cylinder. During this movement of the shaft, the piston 56 remains in abutment with the right-hand sealing collar and the shaft moves relative thereto until snubber 48 is in abutment with the piston. The left-hand piston 54 remains in contact with shoulder 44 on the shaft but moves to the left relative to the cylinder by virtue of the movement of the shaft.

Movement of the shaft to the left causes the gear selector mechanism to rotate (anticlockwise in the drawing) to cause a gear to be selected in the gearbox.

Movement of the shaft to the right (Figure 9) is achieved in the reverse manner by supplying chamber A only with hydraulic fluid which forces the shaft to the right and thus causes rotation (clockwise in the drawing) of the gear selector mechanism thus causing a change of gear to be selected.

Movement of the gear selector mechanism 20 in the axial direction of the shaft 28 is achieved by actuator assembly 18. The actuator assembly 18 is essentially similar to the actuator assembly 16 but with a number of minor modifications. Firstly, chambers A and D have a portion 70, 72 adjacent the ends of the cylinder having a reduced diameter. This portion of reduced diameter provides abutments 62 and 64 past which the pistons are unable to move. Secondly, the left-hand end portion 40 of the shaft 30 is longer than the right-hand end portion 42 and the right-hand portion 34 of the shaft 30 is longer than the left-hand portion 32. The combined length of the left-hand portion 32 and end portion 40 is substantially similar to the combined length of right-hand portion 34 and end portion 42. The actuator assembly 18 of Figures 3 - 6 is arranged to move to four different positions, corresponding to the four rails of a seven-speed gearbox.

Chambers B and C are linked together by piping and connected directly to a constant pressure source (not shown). The constant pressure source is a gas accumulator or other compliant means which provides a constant gas pressure to chambers B and C with the gas acting as a spring. Thus, cylinders B and C are "actuated" if a greater opposite force (caused by pressure fluid in chambers A or D) is not present.

Chambers A and D are controlled by two separate valves to selectively supply pressurised hydraulic fluid thereto.

Movement of the actuator assembly 18 to each of the four positions will now be described. To move the shaft to its left-most position (Figure 3), chamber D is supplied with pressurised hydraulic fluid which forces the shaft 30 to move to the left until the snubber 46 engages with the recess 50 in the end of the cylinder. The movement of the shaft to the left causes the right-hand snubber 48 to abut with the piston 56 which is thus moved to the left also until it

abuts with the right-hand sealing collar 60. The force pushing on the piston from chamber C is overcome due to a 2:1 piston area ratio of chamber D over chamber C. Movement of the shaft to its left-most position causes the gear selector mechanism to slide axially along the shaft 28 to a position corresponding to, for example, the first rail on the gearbox on which gears 1 and 2 are located.

From the left-most position, the shaft 30 is moved to a "middle left" position (Figure 4) in order to move the gear selector assembly to a different rail of the gearbox. This is achieved by supplying pressurised hydraulic fluid simultaneously to chambers A and D such that the pistons 54, 56 move towards each other on the shaft and engage the respective shoulders 44, 45. The shaft thus moves into a central position with the pistons abutting with both the shaft shoulders and the sealing collars. Again, the force pushing on the pistons from chambers B and C is overcome due to the 2:1 piston area ratio of chambers A and D over chambers B and C.

It will be appreciated that this operation is similar to moving the shaft of the first actuator assembly 16 to its middle position. In this case, however, the difference in length of the left portion 32 of the shaft compared with the right portion 34 means that the shaft 30 is moved to a position slightly offset to the left of the central position.

From the middle-left position, the shaft is moved to a middle-right position (Figure 5) to move the gear selector assembly to the third rail of the gearbox. In this case, both chambers A and D are vented to allow the constant fluid pressure in chambers B and C, supplied by the accumulator, to move the pistons 54, 56 away from each other. Owing to the shorter right-end portion 42 of the shaft 30, the right-hand piston 56 collides with the right snubber 48 before the left-hand piston 54 collides with the left snubber 46 and the shaft 30 is therefore moved to the right. The right-hand piston 56 collides with the narrower portion of chamber D whilst the left piston 54 collides simultaneously with the narrower portion of chamber A and the left-hand snubber 46. The shaft 30 is thus moved to a position slightly offset to the right of centre.

From the middle-right position the shaft is moved to the fully-right position (Figure 6) in a manner opposite to the movement of the shaft fully to the left. In other words, chamber A is filled with pressurised hydraulic fluid which moves the shaft to the right until the right-hand snubber 48 engages with the right-hand recess 52 in the end of the cylinder. At the fully right position of the shaft, the right-hand piston 56 is trapped between the shoulder 45 on the shaft and the narrower portion of the chamber D whilst the left-hand piston 54 is trapped between the left snubber 46 and the left-hand sealing collar 58. Movement of the shaft to the fully-right position causes movement of the gear selector mechanism to the last rail on the gearbox.

It will be appreciated that the three position movement of actuator assembly16 and the four position movement of actuator assembly 18 allows the selection of eight different gears with the centre position of the three position actuator assembly representing a neutral gear position. Both of the above described actuator assemblies are provided with only two valves which reduces the control inputs needed to actuate the gear change. It is quite possible, of course, that more valves may be used as necessary in order to selectively supply particular chambers with pressure fluid and little or no modifications to the gear change mechanism are needed to incorporate such alternatives.

While the above embodiment is described in respect of a seven-speed gearbox, the mechanism may equally be applied to a five-speed gearbox in which case the actuator assembly 18 may be replaced by a three-position actuator assembly, similar to that of actuator assembly 16. The gear change mechanism may be used with any existing gearbox layout.

It will be appreciated that the gear change mechanism of the present invention allows for a large number of gears to be selected in a gearbox using a minimum number of valves or associated control mechanisms. This reduces the control inputs required to effect a gear change.

VIEW OF GEAR ACTUATOR
4 VALVE, 2 POSITION

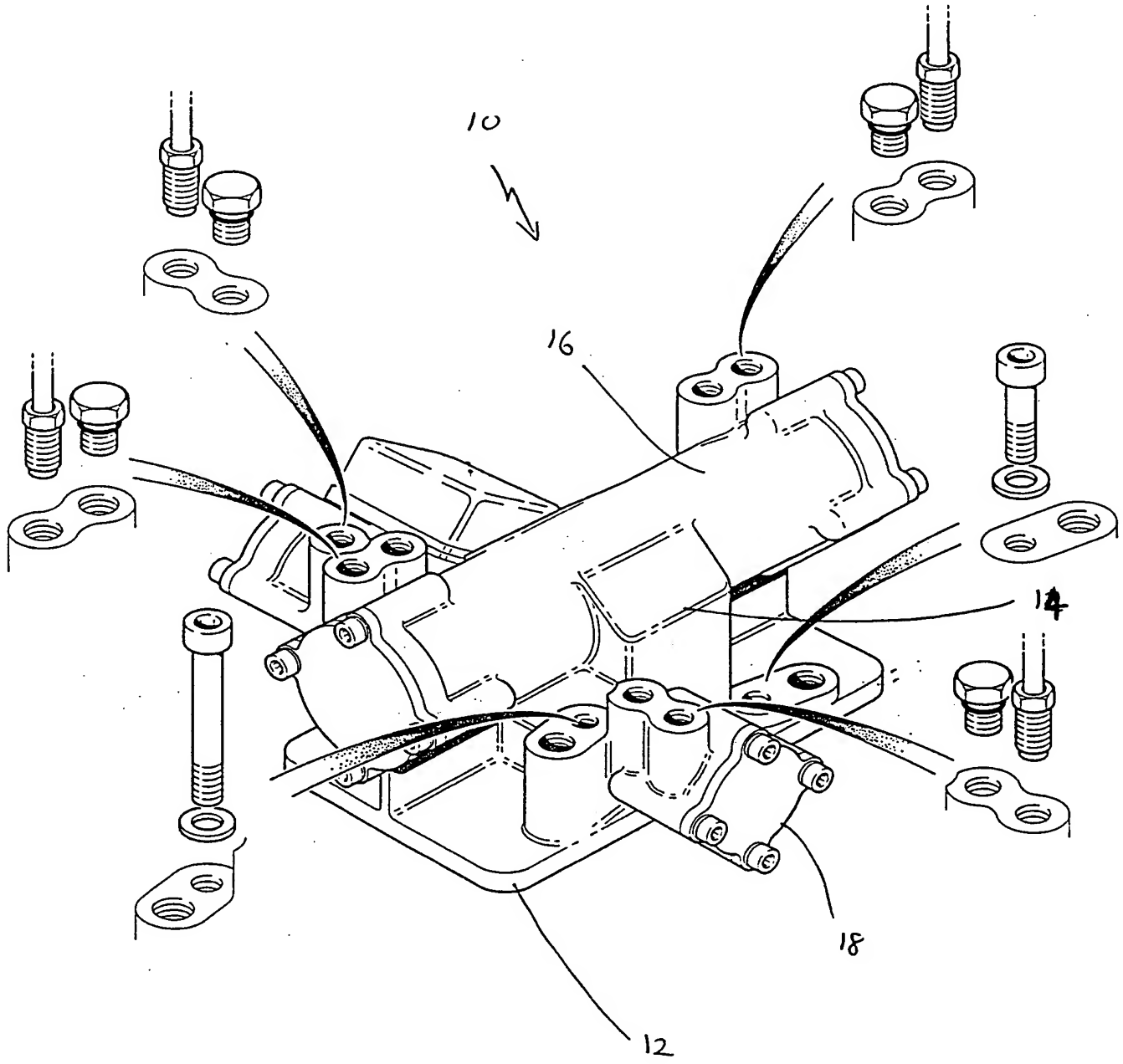

Fig 1

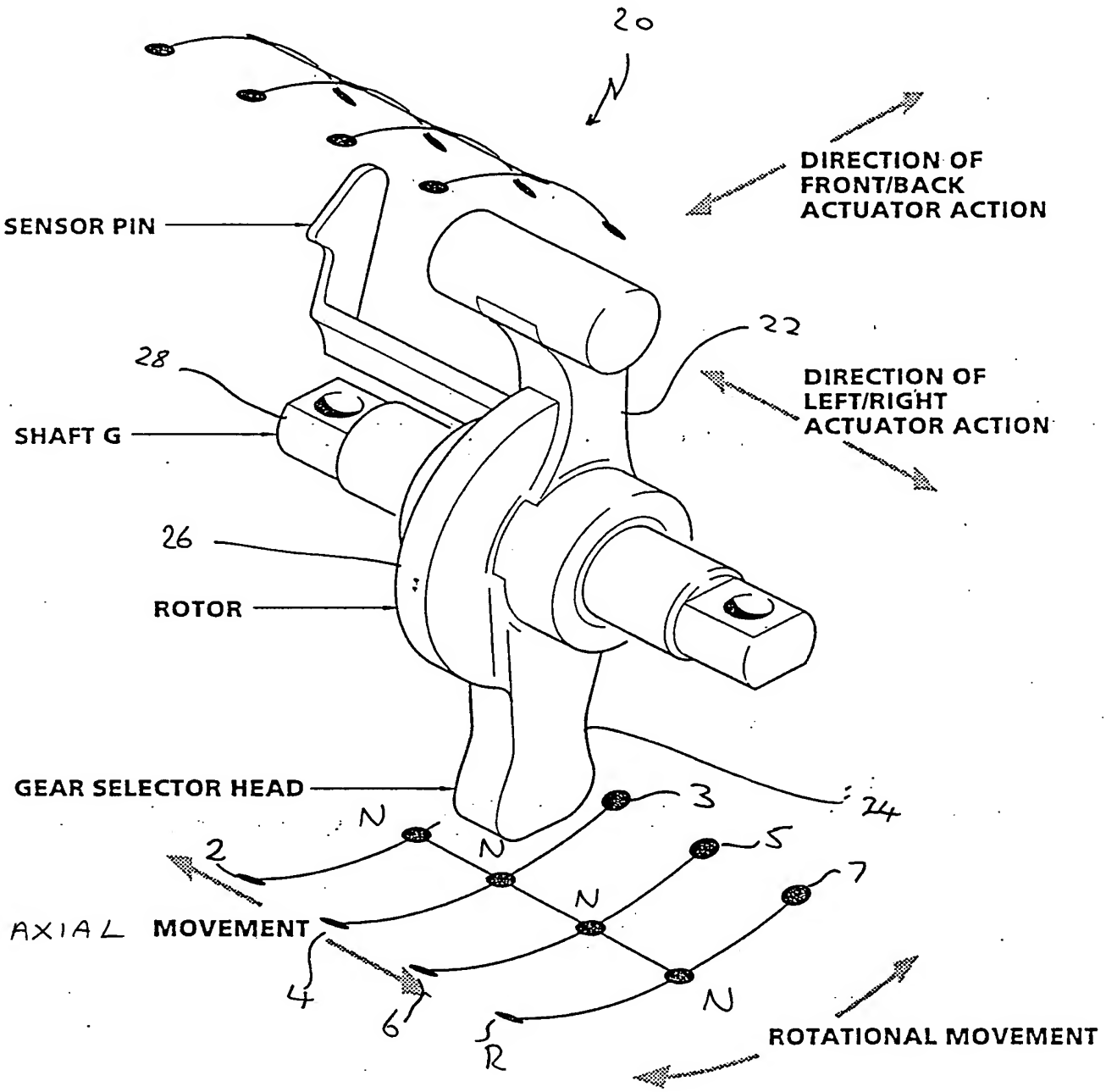
20
N
DIRECTION OF FRONT/BACK ACTUATOR ACTION
SENSOR PIN
22
28
DIRECTION OF LEFT/RIGHT ACTUATOR ACTION
SHAFT G
26
ROTOR
GEAR SELECTOR HEAD
24
3
N
N
2
5
7
N
AXIAL MOVEMENT
4
6
N
5
R
ROTATIONAL MOVEMENT

Fig. 2

RAIL 1, LEFT

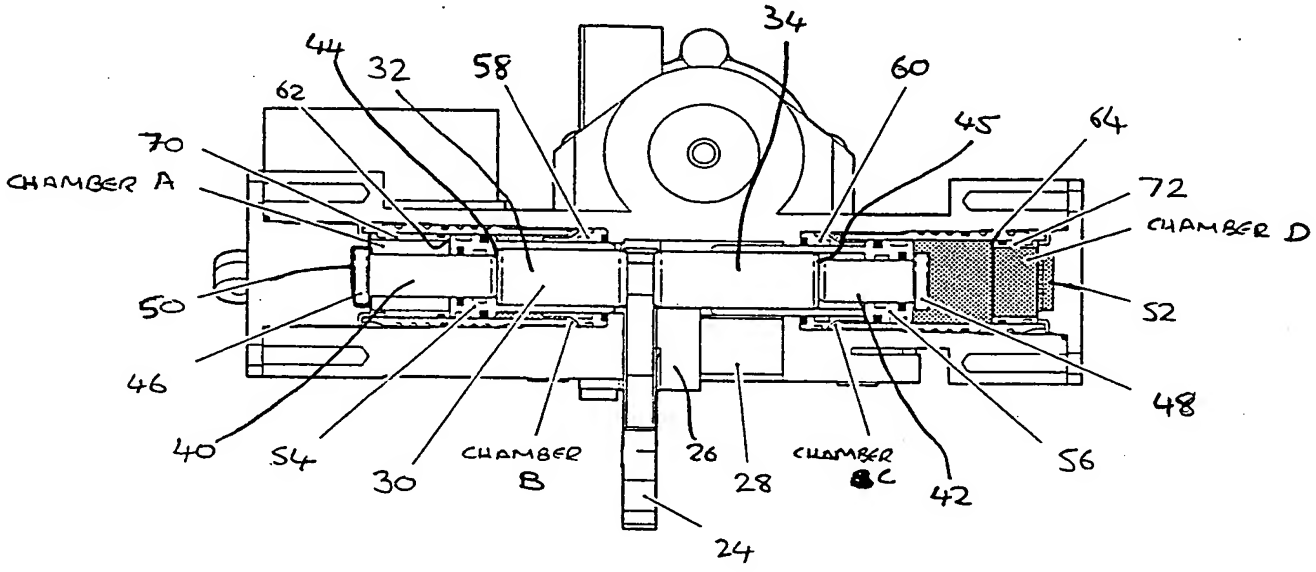

Fig 3

RAIL 4, RIGHT

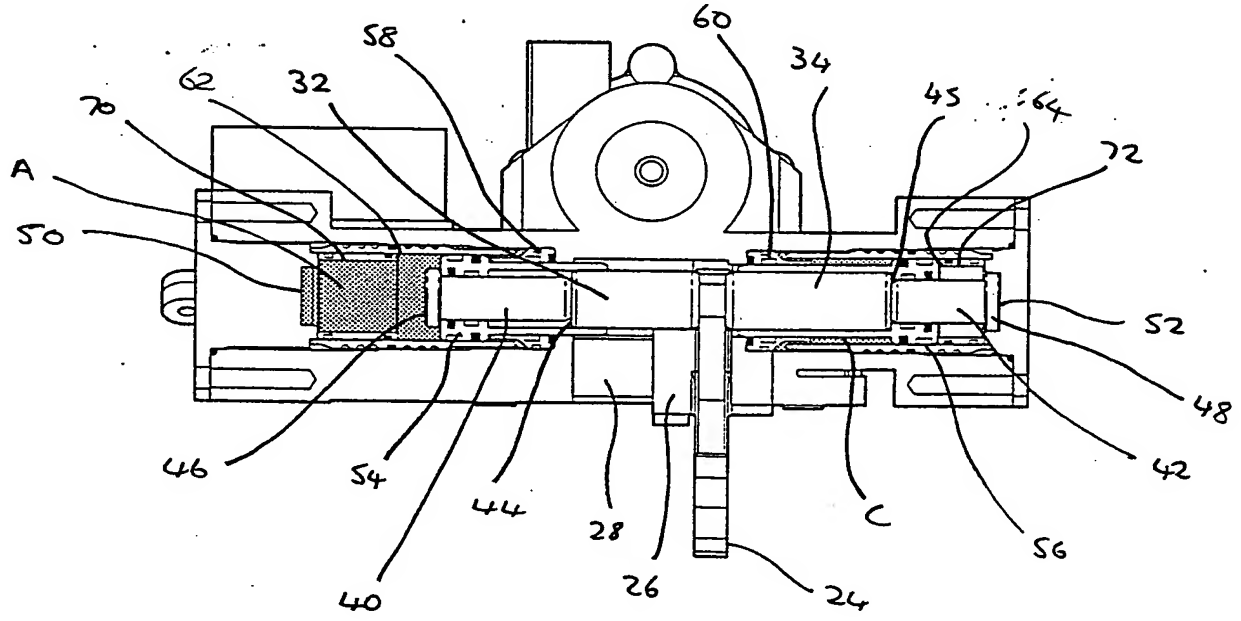

Fig 6

RAIL 2, MIDDLE LEFT

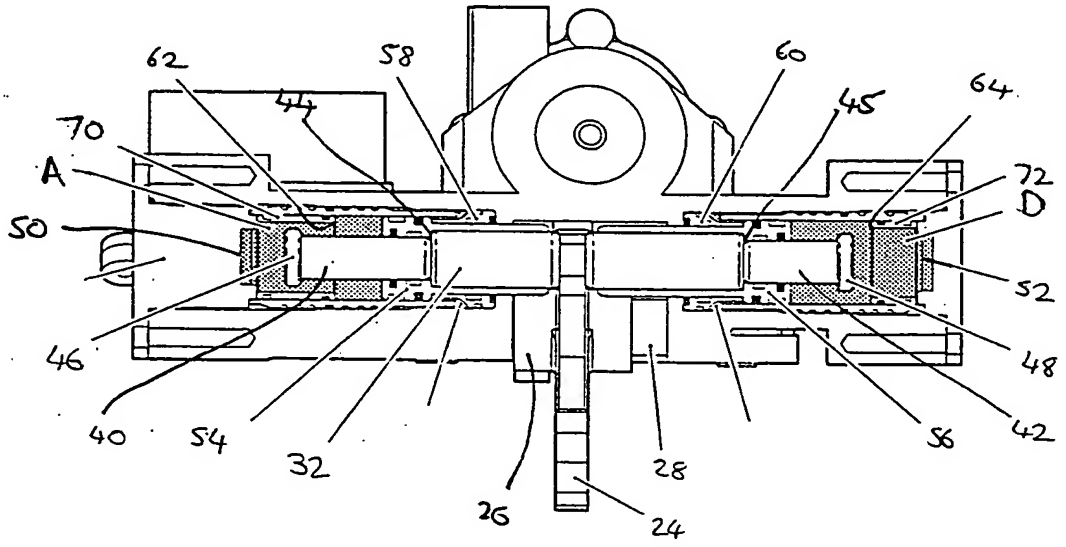

Fig 4

RAIL 3, MIDDLE RIGHT

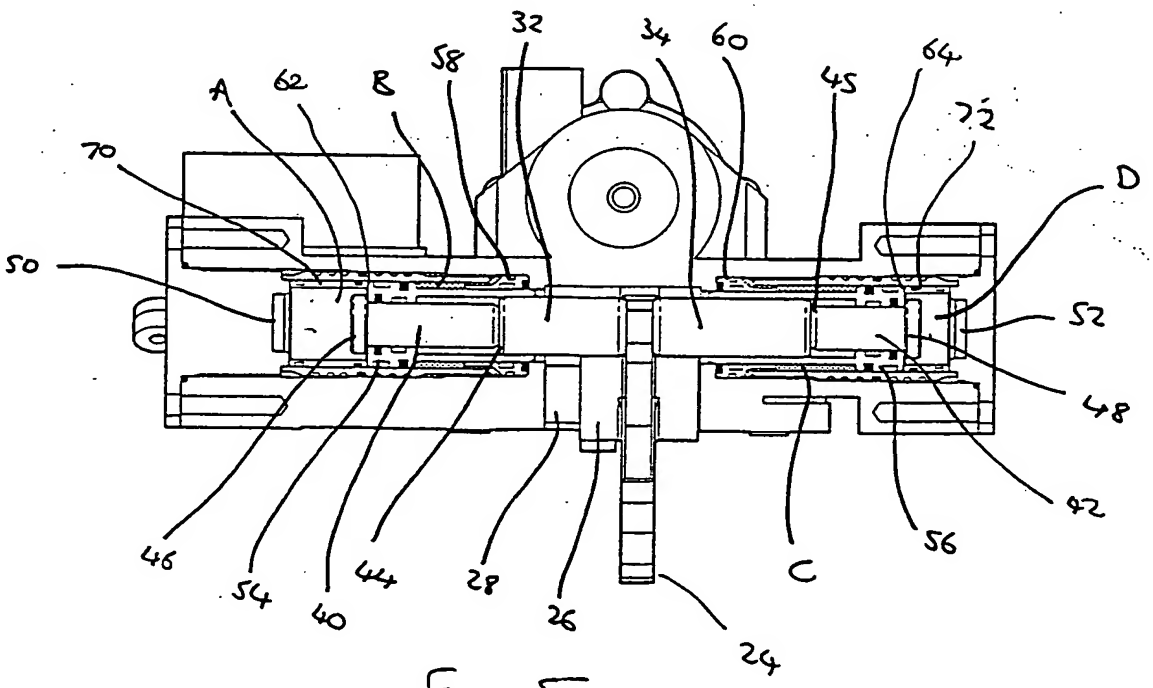

Fig 5

prodrive

FRONT BACK ACTUATOR
3 POSITION, 2 VALVE

CENTRAL

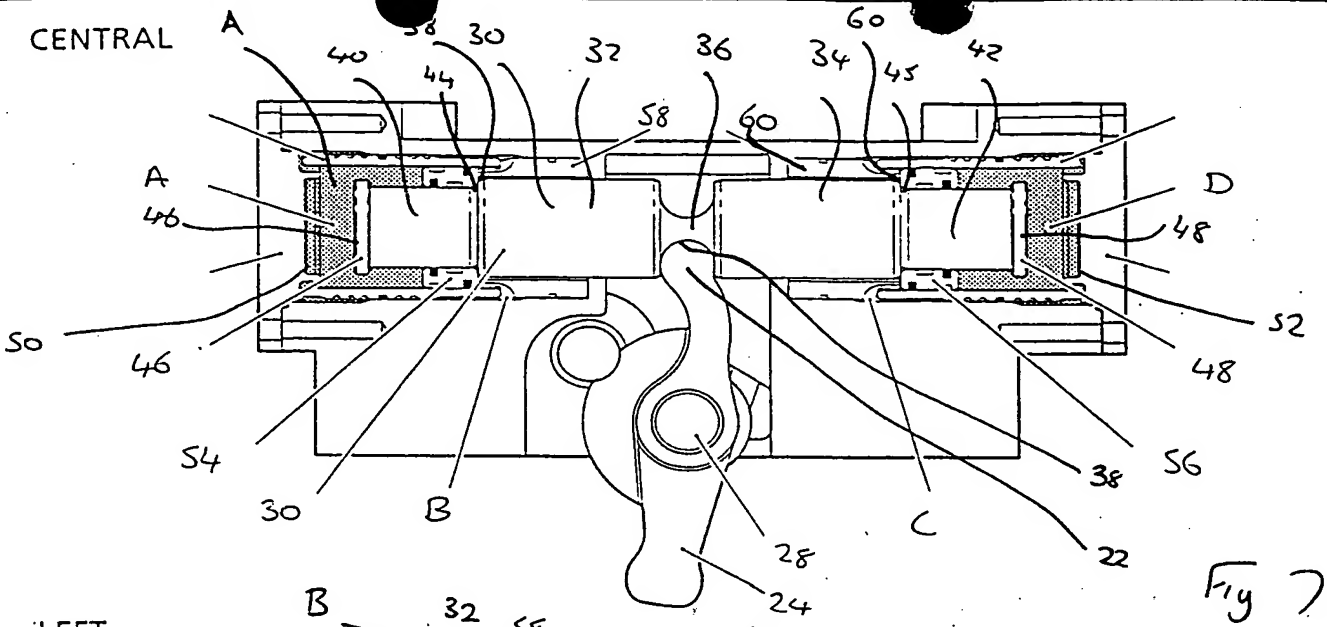

Fig 7

LEFT

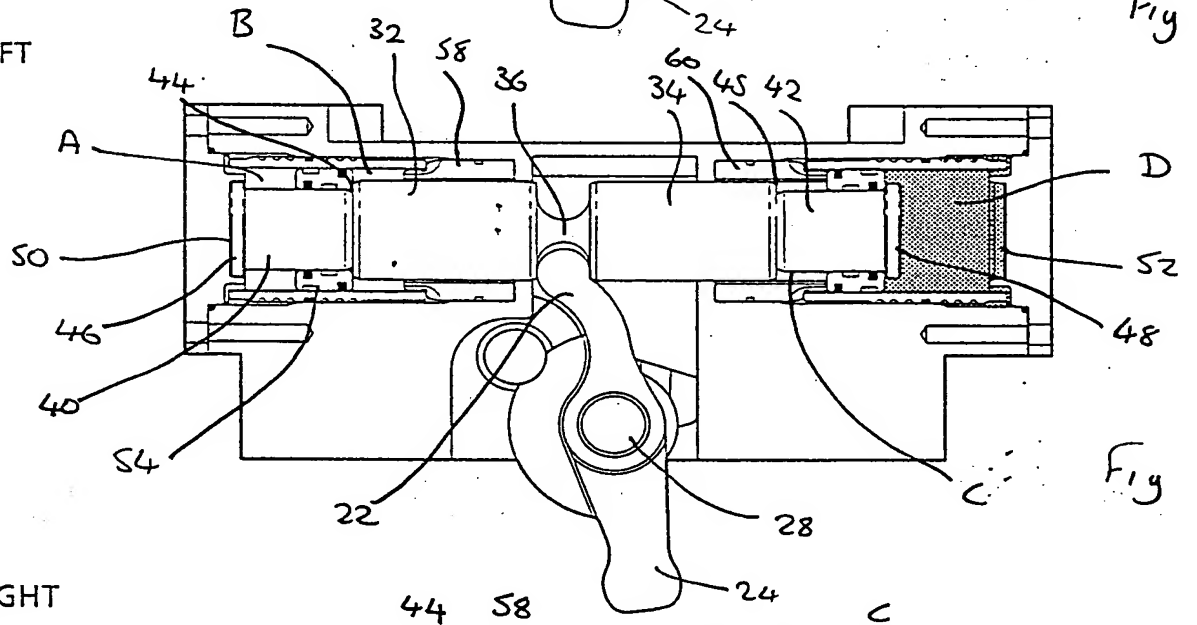

Fig 8

RIGHT

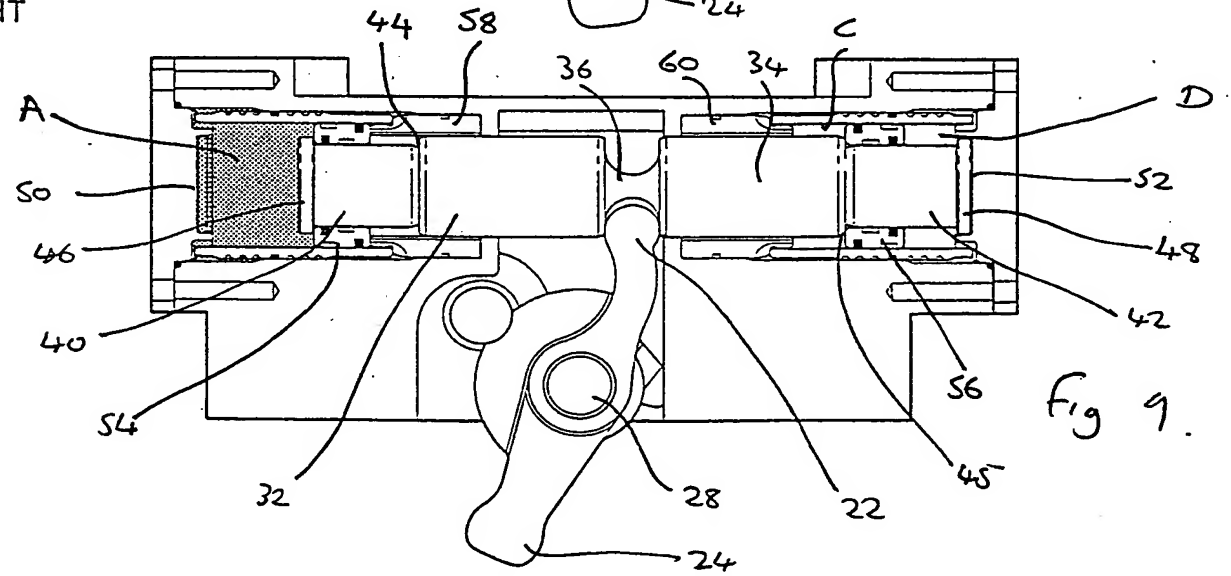

Fig 9.